Strat Traum Limb Recon (2007) 2:59–61
DOI 10.1007/s11751-007-0024-6

ORIGINAL ARTICLE

Corrective osteotomy after malunion of mid shaft fractures of the clavicle

R. J. Hillen · D. Eygendaal

Received: 28 September 2007 / Accepted: 21 November 2007 / Published online: 6 December 2007

Abstract Displaced mid shaft fractures of the clavicle result in some degree of shortening and rotation. These fractures often heal with some degree of malunion which can be symptomatic. The question arises as to whether surgical correction of the deformity will relieve the symptoms associated with the malunion. Ten patients with a symptomatic malunion of the clavicle were treated by means of a corrective osteotomy with plate and screw fixation. Outcome measurement was a pre and postoperative DASH score, range of motion and patient satisfaction. At follow up after a mean duration of 37 months there was a significant improvement of the DASH score, eight patients were satisfied, and range of motion did not differ significantly. Two patients had a complication resulting from the surgical procedure.

Keywords Clavicle/injuries · Fractures · Malunited/complications · Osteotomy/methods

Introduction

A fracture of the clavicle is a common injury (4–12% of all fractures). Over two-third of these fractures involve the mid shaft (Allman type I [1]). Conservative treatment is the method of choice for most type I fractures [2]; however, when displaced, it usually results in some degree of shortening [3–5]. Several studies show excellent results after conservative treatment [5–8] and show only cosmetic problems as a result of shortening. Recent studies using a patient based outcome score show a less favourable outcome resulting from conservative treatment [4, 9, 10]. Patients complain of pain, weakness, rapid fatigability, numbness or paraesthesia of the arm and hand as well as cosmetic complaints. Nowak et al. [11] have determined predicting factors on first presentation with regard to sequelae. Indications for primary surgical treatment of clavicular fractures include an open fracture or when the neurovascular structures are compromised [2, 7]. Severe dislocation and angulation are also considered an indication for surgical treatment as closed reduction seldom results in a sustained improvement of the alignment [7]. Reasons for secondary surgical treatment are delayed or non-union and malunion with sequelae [2, 3, 7, 9, 10, 12]. We treated a group of patients who complained of pain after a malunion of the clavicle with a corrective osteotomy. The objective of this retrospective study is to determine the (long term) results of this treatment as well as the possible complications.

Materials and methods

This paper represents a retrospective study of ten patients (six females, four males) with an average age of 40 years (range 21–57 years), with a symptomatic malunion of the clavicle. Surgical correction was performed using the technique as recently described by McKee et al. [13]. The approach was done through an oblique incision along the superior margin of the clavicle. After exposing the malunion, a sliding osteotomy was performed through the original fracture plane to correct the shortening (and

R. J. Hillen (✉)
Vrije Universiteit Medical Center, De Boelelaan 1117,
1081 HV Amsterdam, The Netherlands
e-mail: R.Hillen@VUmc.nl

D. Eygendaal
Amphia Hospital, Molengracht 21, 4818 CK Breda,
The Netherlands

rotation). The medullary canal was re-established with a drill and fixation is done with a pelvic reconstruction plate (Synthes GmbH, Solothurn, Switzerland) with three bicortical screws on each side of the osteotomy. The plate was placed on the postero-superior side(Fig. 2). Bone grafting was not necessary in this group of patients. All procedures were performed by the senior author (D.E.). These patients presented at the outpatient department with ongoing pain in the shoulder region after a "healed" clavicular fracture. In nine out of ten patients, the fracture was due to a high-energy trauma (e.g. road traffic accident, horse riding accident). All had sustained a mid-shaft dislocated fracture as an isolated injury. The mean time between the fracture and the correction osteotomy was 25 months (SD 30, Table 1). The most important complaint these patients had was pain in the shoulder and loss of strength in the arm. We tested the pre- and post-operative shoulder function using the disability of the arm shoulder and hand (DASH) score [14]. In this scale, 0 indicates a perfect function of the upper extremity, and 100 is complete loss of function. A normal population has an average score of 5 [4]. We determined the pre- and post-operative range of motion and complications of the surgical treatment. We asked the patients if they were satisfied with the results of the operation. The mean pre-operative score was 78 (range 53–100, SD 14.9, Table 1). None of these patients had signs of brachial plexus lesion. The average amount of shortening was 2.4 cm (range 1.5–3.5 cm, SD 0.8, Table 1) in comparison to the uninjured side as measured on a bilateral PA shoulder radiograph. Indication for surgery was ongoing pain in the shoulder with a malunion of the clavicle having a shortening of 1.5 cm or more and no other cause for the pain could be found. The follow-up was done independently by the junior author (R.J.H.).

Results

A significant ($P < 0.005$, Student t test) decrease in DASH-score was found (Table 1) as a result of the operation. There was no significant difference in the pre- and post-operative range of motion. Patients satisfaction were tested by asking the patient whether he or she would undergo the same surgical procedure again, given the same circumstances. Eight out of ten stated they would, one was in doubt and one would refuse. Complications were seen in two of the ten patients; one sustained a deep infection, and the other had a nonunion and needed further treatment. The mean follow up was 37 months (range 14–56, SD 17, Table 1). The largest amount of decrease in DASH score was seen in patients who were operated on within 1 year after the fracture. The difference in DASH-score decrease with the rest of the group was significant ($P < 0.02$); however, due to the small number of patients, this difference can only be seen as a subject of interest for further study. In seven of the ten patients, the plate and screws were removed due to symptoms (Figs. 1, 2).

Discussion

Displaced mid shaft fractures of the clavicle result in some degree of shortening due to opposing forces acting upon the bone. The sternocleidomastoid muscle pulls the medial fragment superiorly and posteriorly, whilst the pectoralis major muscle, the deltoid muscle and gravity pulls the lateral fragment inferiorly and anteriorly [2]. Traditional teaching has been that malalignment of clavicular fractures rarely causes problems. More recent studies, in which the outcome tests were more patient-based rather than just

Table 1 Data on the ten patients

	Shortening (in cm)	Pre operative DASH[a] score	Post operative DASH[a] score	Follow up (in months)	Complication	Time between fracture and correction (in months)
1	3.2	72	39	14	No	85
2	2.0	53	26	54	No	261
3	1.5	100	72	14	No	13
4	1.8	88	2	56	No	10
5	2.2	96	44	46	No	17
6	2.5	63	48	18	No	16
7	3.5	75	36	53	Yes	26
8	2.1	67	73	49	Yes	74
9	3.5	85	33	41	No	5
10	1.3	82	74	22	No	257
Mean	2.4	78	45	37		25
Standard deviation	0.8	14.9	23.2	17		30

[a] Disabillity of the arm shoulder and hand [14]

Fig. 1 Malunion of a mid shaft clavicle fracture

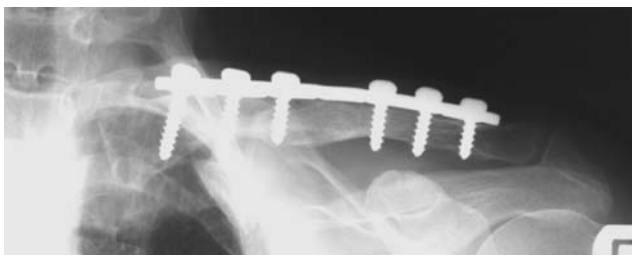

Fig. 2 Situation after corrective osteotomy with plate and screws

radiological, show less favourable outcomes of a malunion [4, 9, 10, 12]. Nowak et al. [12] showed that functional impairment after a malunion with shortening is not exceptional; in a prospective consecutive series of 222 clavicular fractures, 42% had sequelae at 6 months; primary displacement was the strongest radiologic risk factor. Our study suggests that better results can be obtained by correcting the deformity within the first year. This can only be regarded as a topic for further studybecause, although the difference in DASH-score is significant, the number of patients thathave been treated within 1 year(n = 2) is too small to draw any definitive conclusions.The drawbacks of our study are the small number of patients (though one of the largest in recent literature) and the retrospective setup. McKee et al. [10] showed similar outcomes to our study as do other authors [15, 16]. A clavicular fracture with significant shortening is not such a "benign" lesion as is commonly thought [9, 12] and maybe there is an argument to perform ORIF when there is more than 20 mm shortening [4, 17, 18] in the young and active group. Currently, we are studying the amount of symptomatic malunions in a consecutive series of conservatively treated clavicular fractures and a study where the effect of shortening of the clavicle on the biomechanics of the shoulder girdle is measured.

Conclusion

Correction after a malunion seems to be an option in case of a symptomatic malunion of a mid shaft fracture of the clavicle; however, risk of complications should be taken into consideration. A second operation to remove plate and screws is often necessary.

References

1. Allman FL Jr (1967) Fractures and ligamentous injuries of the clavicle and its articulation. J Bone Joint Surg Am 49:774–784
2. Neer CS (1984) Fractures of the clavicle. In: Rockwood CA Jr, Green DP (eds) Fractures in adults, 2nd edn. Lipincott, Philadelphia, pp 707–713
3. Edelson JG (2003) The bony anatomy of clavicular malunions. J Shoulder Elbow Surg 12:173–178
4. Hill JM, Mc Guire MH, Crosby LA (1997) Closed treatment of displaced middle third fractures of the clavicle gives poor results. J Bone Joint Surg 79-B:537–539
5. Nordqvist A, Redlund-Johnell I, von Scheele A, Petersson CJ (1997) Shortening of clavicle after fracture. Acta Orthop Scand 68:349–351
6. Eskola A, Vainionpää S, Myllynen P, Pätiälä H, Rokkanen P (1986) Outcome of clavicular fractures in 89 patients. Arch Orth Trauma 105:337–338
7. Rowe CR (1968) An atlas of anatomy and treatment of the midclavicular fractures. Clin Orthop 58:29–42
8. Stanley D, Norris SH (1988) Recovery following fractures of the clavicle treated conservatively. Injury 19:162–164
9. Ledger M, Leeks N, Ackland T, Wang A (2005) Short malunions of the clavicula: an anatomic and functional study. J Shoulder Elbow Surg 14:349–354
10. McKee MD, Wild LM, Schemitsch EH (2003) Midshaft malunions of the clavicle. J Bone Joint Surg Am 85:790–797
11. Nowak J, Holgersson M, Larsson S (2004) Can we predict long-term sequelae after fractures of the clavicle based on initial findings. J Shoulder Elbow Surg 13:479–486
12. Nowak J, Holgersson M, Larsson S (2005) Sequelae from clavicular fractures are common: a prospective study of 222 patients. Acta Orthop 76:496–502
13. McKee MD, Wild LM, Schemitsch EH (2004) Midshaft malunions of the clavicle.Surgical technique. J Bone Joint Surg Am 86:37–43
14. Hudak PL, Amadio PC, Bombardier C (1996) Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand) [corrected]. The Upper Extremity Collaborative Group (UECG). Am J Ind Med 30:372
15. Bosch U, Skutek M, Peters G, Tscherne H (1998) Extension osteotomy in malunited clavicularfractures. J Shoulder Elbow Surg 7:402–405
16. Shaun Simpson N, Jupiter JB (1996) Clavicular non union and malunion: Evaluation and surgical management. J Am Acad Orth Surg 4:1–8
17. Canadian Orthopaedic Trauma Association (2001) None operative treatment comparedwith plate fixation of displaced midshaft clavicular fractures. J Bone Joint Surg Am 89:1–10
18. McKee MD, Wild LM, Schemitsch EH (2004) Does delaymatter? The restoration of objectively measured shoulder strength and patient-orientedoutcome after immediate fixation versus delayed reconstruction of displaced midshaftfractures of the clavicle. J Shoulder Elbow Surg 16:514–518